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A PRESCRIPTION FOR THE MANAGEMENT OF AN ALL-AGED
STAND IN THE WEST TWIN CREEKS DRAINAGE OF MONTANA

By

Wayne A. Hite

B.S., Iowa State University, 1968

Presented in partial fulfillment of the requirements for

the degree of

Master of Forestry

UNIVERSITY OF MONTANA

1977

Approved by:



Chairman, Board of Examiners



Dean, Graduate School

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Hite, Wayne A., M.F., November 21, 1977

Forestry

A Prescription for the Management of an All Aged Stand in the West
Twin Creeks Drainage of Montana (37 pp.)

Director: Mr. James L. Faurot

A management plan for a 73.7 acre all aged stand located northeast of Missoula, Montana is described. The steep southwest slopes are characterized by warm, dry habitat types, primarily Douglas-fir/Calamagrostis rubescens and Douglas-fir/Agropyron spicatum, and by shallow soils of the Winkler-Sharrott Association. The present timber stand averages approximately only 49 square feet of basal area per acre and 1,584 board feet of merchantable fiber per acre. The objective for this stand is to maintain full fiber productivity where economically justified and with consideration for environmental and wildlife constraints. The selected prescription for the stand is to intensively manage a portion of the acreage for a maximum return on investment while the remaining 27 acres will be treated as a special impact area, because of the desirability as a wildlife winter range. A forty-year regulation period will accomplish conversion to a modified, balanced, uneven-aged stand that will be subsequently entered at ten-year intervals.

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I. STAND DESCRIPTION

Location

The stand being evaluated is located in the West Twin Creeks drainage on the Blackfoot District of Champion International Corporation's Montana timberlands. It comprises 73.7 acres in the E $\frac{1}{2}$ NE $\frac{1}{4}$ of Section 33, and portions of the S $\frac{1}{2}$ NW $\frac{1}{4}$ and N $\frac{1}{2}$ SW $\frac{1}{4}$ of Section 34, T14N, R17W, P.M.M.

The site is thirteen miles northeast of Champion's milling facilities at Bonner, Montana and is within two miles of the logging headquarters at the mouth of East Twin Creeks (see maps, Figures 1 and 2).

Sixty percent of the drainage is in Champion's ownership, with 24 percent Federal (USFS) and 16 percent owned by the Burlington Northern.

Topographic Features

The lower boundary of the stand is at an elevation of 4,000 feet, along a spur road which parallels, about 150 feet away, West Twin Creeks. The upper boundary (elevation 4,720 feet) is on the ridge dividing the West Twin and North Fork West Twin Creeks drainages.

The aspect is southwest while the slopes generally range between 30 and 50 percent. There are two benches, comprising about four acres, on the lower portion of the stand that have slopes of 0 to 10 percent.

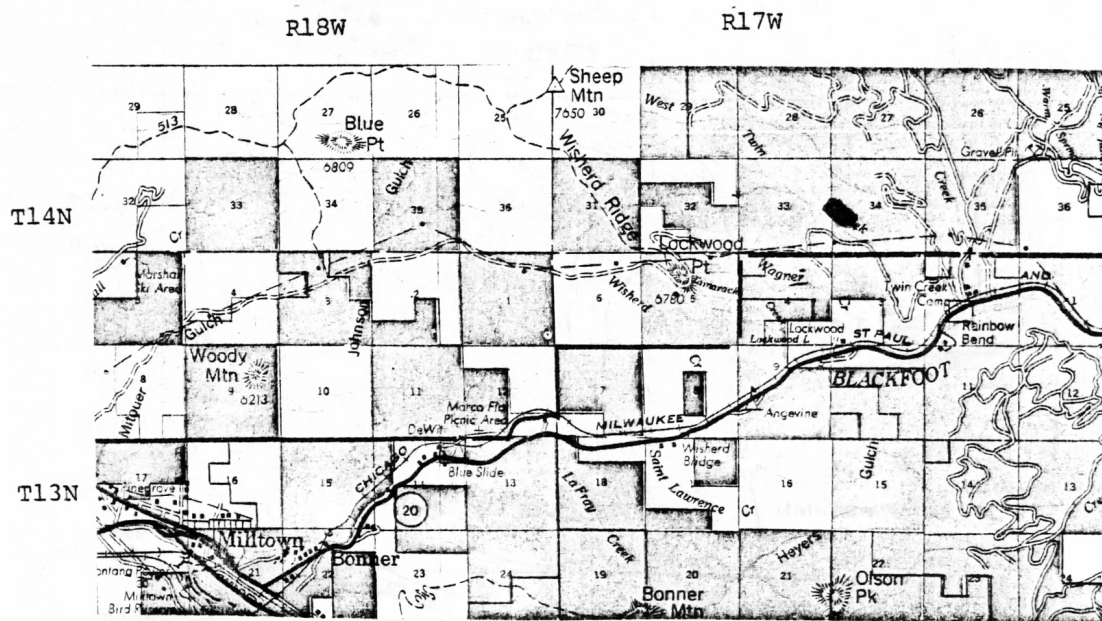


Figure 1. General site location.

Scale: $\frac{1}{4}$ " = 1 mile

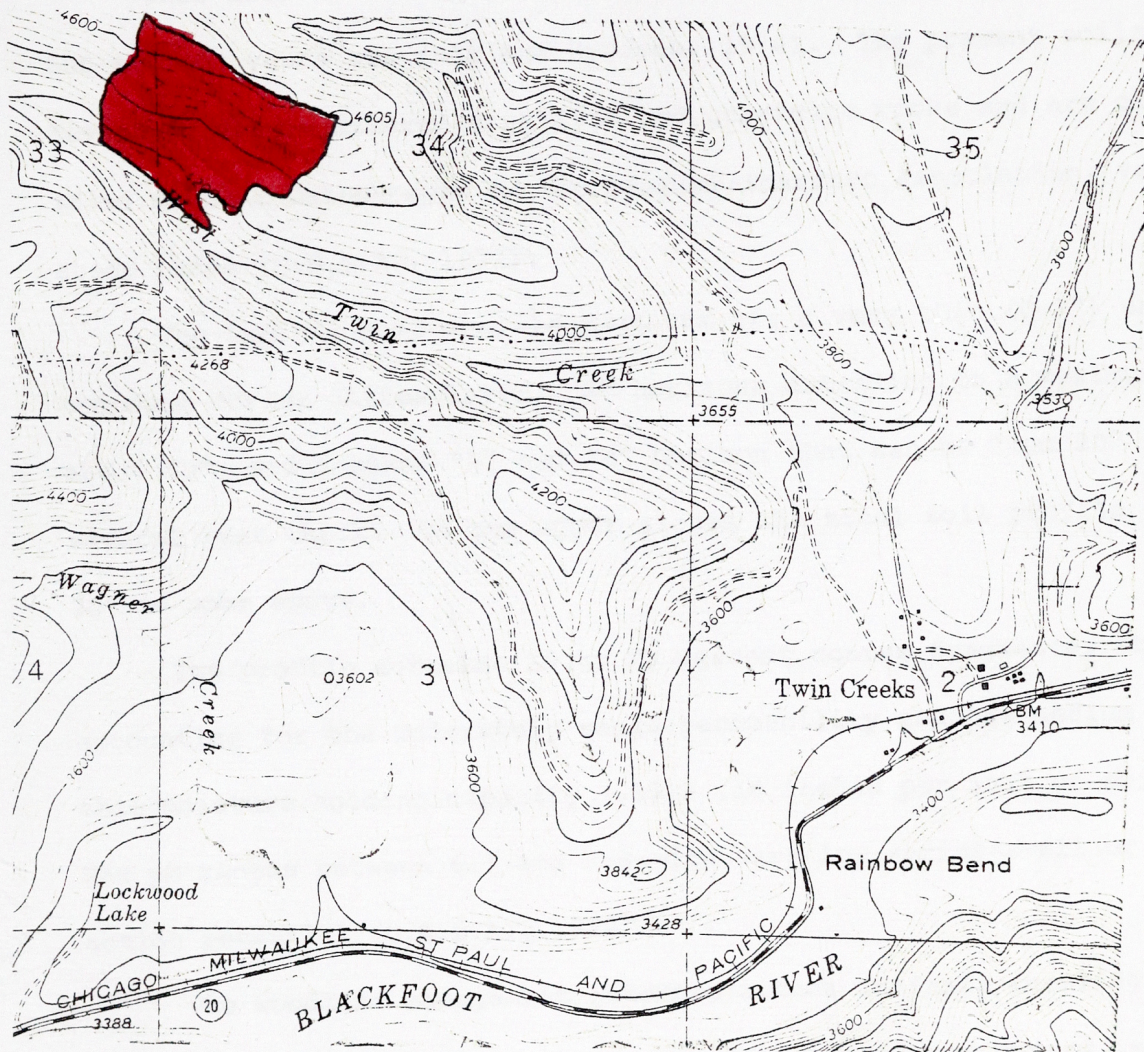


Figure 2. Site location in T14N, R17W. Scale: 2.625" = 1 mile

There is a small seep located 660 feet north and 260 feet east of the one-quarter corner between Sections 33 and 34.

Geology and Soils

This area is underlaid by Precambrian sandstone which formed some 600 million years ago (Alt and Hyndman, 1974). The present soils have developed from weathered argillite and quartzite rocks and are classified as Udic Ustochrepts of the Winkler-Sharrott Association, very steep phase (U.S.D.A., 1972).

The typical soil profile consists of: a very thin (0-1") undecomposed forest litter layer, "A" horizons extending to a maximum of about 40", and a mixed "A" and "B" horizon that can be from 20" to several feet thick. On the upper slopes the total soil profile is only 20" in some spots.

The profile contains 35 to 75 percent coarse fragments, thus accounting for the moderately rapid permeability and the medium available moisture holding capacity (.12 - .16 inches per inch of soil). The pH ranges between 6.1 and 7.3 with very low shrink-swell or frost action potential (U.S.D.A., 1972).

The woodland management interpretations indicate seedling mortality and plant competition are severe, windthrow hazard is slight and, due to steep slopes, erosion hazard and equipment limitations are moderate (U.S.D.A., 1972).

Climate and Hydrology

The stand's climate is influenced by the Bitterroot Mountain range 57 miles to the west, and by the 7,650-foot Sheep Mountain 3

miles west, northwest.

From onsite weather records of four years, the site is characterized as hot and dry in the summer with mean daily high temperatures during August of $87.0^{\circ} \pm .3^{\circ} \text{F}$ (2 standard deviation), and average July, August and first half of September precipitation of $1.95" \pm .41"$ (2 standard deviation), for the seventy-seven day period.

The winters are cold and moderately wet and, although four feet of snow may fall between November 1 and April 1, there is rarely over 8 inches of snow on the site at any time. The mean annual precipitation for the site, as estimated from maps furnished by the Soil Conservation Service, is 21 inches of which $8.84 \pm .78$ inches occurs as rainfall. The rainfall component was determined by onsite measurements.

West Twin Creeks is a perennial stream flowing an annual mean of about 35 cubic feet per second at its junction with the Blackfoot River (Weisel and Newell, 1970). No long-term or periodic flow measurements have been made on the stream above the confluence of the North Fork, thus any figures used are very rough estimates based on a single measurement above this point. The branch that flows through the drainage that this stand is located in flows about 16 cubic feet per second. This branch drains 3,008 acres of timberland with an estimated annual water yield of 11,580 acre feet.

Using the average annual precipitation for the drainage (26 inches), the average water yield from precipitation is estimated at 6,520 acre feet annually. The difference between the water yields

(11,580 - 6,520) suggests that approximately 5,000 acre feet of water is entering the drainage by sub-surface flow.

Vegetation

The tree species found on this site are predominately ponderosa pine (Pinus ponderosa Laws.) and Douglas-fir (Pseudotsuga menziesii var. glauca Franco.) with minor amounts of lodgepole pine (Pinus contorta var. latifolia Engelm.) and western larch (Larix occidentalis Nutt.) occurring on the lower elevation benches.

The understory vegetation has as its major components:

Xerophyllum tenax (Pursh) Nutt., Balsamorhiza sagittata (Pursh) Nutt., Achillea millefolium Piper, Festuca idahoensis Elm., Carex geyerii Boott, Calamagrostis rubescens Buckl., Agropyron spicatum (Pursh) Scribn. & Smith, Arctostaphylos uva-ursi (L.) Spreng., Ceanothus velutinus Dougl., Pachistima myrsinites (Pursh) Raf., Berberis repens Lindl., Amelanchier alnifolia Nutt., and Arnica cordifolia Hook.

In typing and mapping (Figure 3) the vegetative community, six unions were identified (Pfister et al., 1974).

Douglas-fir/Xerophyllum tenax (DF/Xete) 4.0 acres

The presence of Larix occidentalis and Pinus contorta identify this site as being cooler and moister than the rest of the stand. Little grazing use is expected by domestic stock with light deer and elk use occurring in the spring or fall. Timber productivity is considered moderate.

Douglas-fir/Calamagrostis rubescens (DF/Caru) 42.9 acres

The phase represented here is Agropyron spicatum which

indicates the warmest and driest extreme of this habitat type. The profuse occurrence of both Calamagrostis and Carex geyerii results in severe competition with tree seedlings. However, an open overstory canopy appears to create a warmer than optimal microclimate for Calamagrostis, and this species decreases in site occupancy. This habitat type is considered to be a potentially key winter range for elk and deer. Timber productivity is again considered moderate.

Douglas-fir/Agropyron spicatum (DF/Agsp) 20.6 acres

This is the warm, dry extreme of the Douglas-fir climax series and tends to have a savanna-like appearance. It is found occurring where the soils are shallow. Although the forage value for domestic grazing is moderate to good, the steeper slopes limit its use. It does, though, have a high value as a winter range for both deer and elk, because of the light snow cover normally associated with the warm exposure and low tree canopy cover. Site indexes are low on this habitat type and when coupled with the light stocking levels results in little justification for intensive timber production.

Douglas-fir/Festuca idahoensis (DF/Feid) 0.3 acres

This minor type occurs in the cool, moist drainage-way below the wet seep. The management implications are similar to the DF/Agsp habitat type.

Nonforest/Agropyron spicatum (NF/Agsp) 5.6 acres

This union has very shallow soils and tends to be too

28	27
33	34

T14N, R17W



- Wet Seep -
- DF/Caru -
- DF/Agsp -
- NF/Agsp -
- DF/Xete -
- DF/Feid -

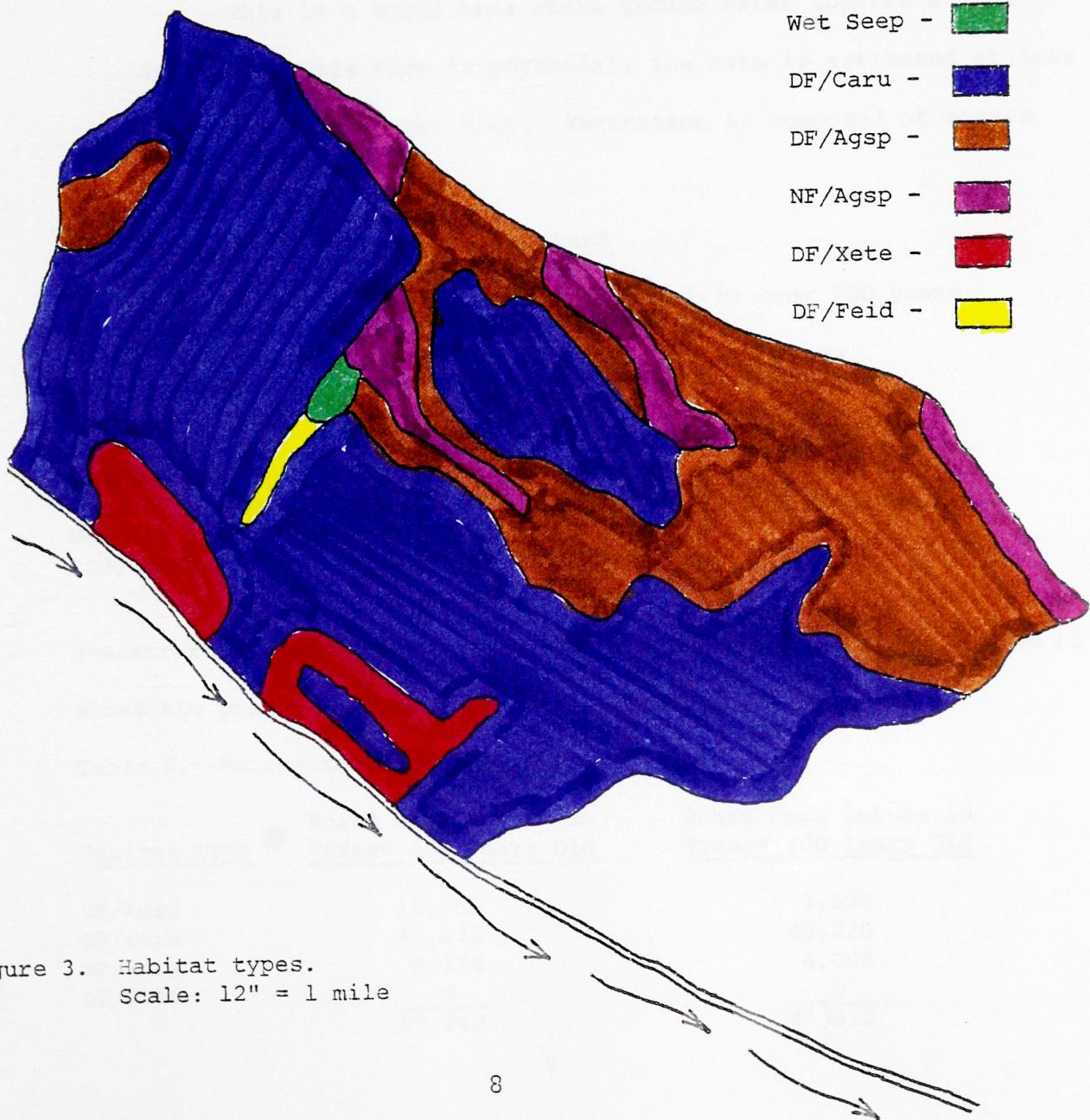


Figure 3. Habitat types.
Scale: 12" = 1 mile

droughty to support trees. Evidence exists that the Douglas-fir and ponderosa pine encroach into the grass lands during cool, moist years and are killed during warm, dry summers. Although these sites are well suited to domestic grazing from a forage standpoint, the steeper slopes preclude much use. These are important winter ranges for deer and elk.

Wet Seep, 0.3 acres

This is a boggy area where ground water appears at the surface. While flow is perennial, the rate is estimated at less than five gallons per hour. Vegetation is composed of mosses and lichens.

Statistics of the Present Timber Stand

The present stand ranges in age from 1 to over 200 years.

Table 1.--Mean stocking per acre by species, all trees.

<u>Species</u>	<u>Stems/Acre</u>		<u>Basal Area/Acre (Sq. Ft.)</u>	
Douglas-fir	379	79	34.23	16.15
Ponderosa Pine	139	45	14.44	5.76
Western Larch	4	4	.04	.04
Lodgepole Pine	4	4	.24	.24
	525	104	48.95	15.84

The errors are at the 2 standard deviation level. Figure 4 on page 11, shows the present stocking levels by diameter class.

Table 2.--Merchantable volume in the stand

<u>Habitat Type</u>	<u>Board Foot Volume in Trees < 200 Years Old</u>	<u>Board Foot Volume in Trees > 200 Years Old</u>
DF/Agsp	16,350	3,090
DF/Caru	46,820	40,220
DF/Xete	6,270	4,000
DF/Feid	0	0
	69,440	47,310

The total merchantable volume of 116,750 board feet averages 1,584 board feet per acre for the total stand. Statistics on the present stand were developed from a systematic sample using variable probability plots.

For tax purposes the area encompassed by the DF/Agsp habitat type is classified by the State of Montana as a P9P, while the DF/Caru, DF/Feid and DF/Xete habitat types are classified as D8P. All are classed as average in access and topography. The remaining 5.9 acres are classed as non-forest. All 73.7 acres have a G6 grazing tax rate.

Genetics

Prior to harvesting activities in the early 1930's, it is suspected that this stand was able to maintain wide genetic diversity because of the low incidence of severe wildfires, the absence of geographic isolation, and the ecological variation of the site (Howe, 1974).

The main selection pressures would have been toward drought resistance in the ponderosa pine and Douglas-fir on the upper slopes (DF/Agsp habitat type), and toward frost hardiness (Rehfeldt, 1974) in all species on the DF/Feid and DF/Xete habitat types.

After harvesting, a genetic bottleneck in Douglas-fir and ponderosa pine was created. The harvesting operation removed those trees with the best form and smallest branches leaving about ten trees per acre. Of the traits shown to be most highly heritable (Howe, 1974, Libby, 1975), wide crowns seem to prevail in the siblings from these seed trees.

The lodgepole pine and western larch on the DF/Xete habitat type

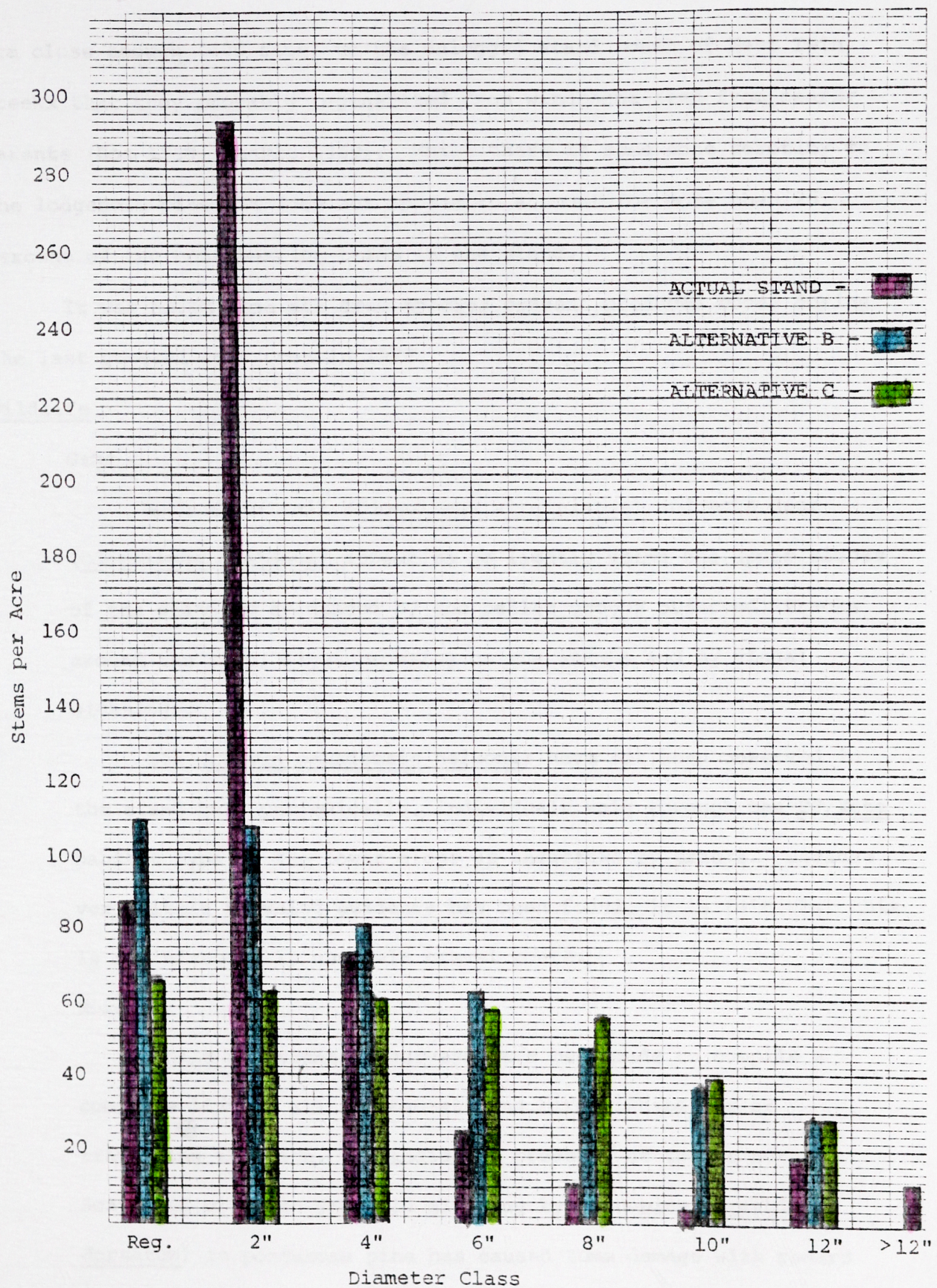


Figure 4. Frequency distribution of diameters

are close enough (400 feet) to the unlogged stand south of West Twin Creeks that they probably regenerated from windborne seed from nearby parents (Boe 1958, Tackle 1959). While there is some cone serotiny in the lodgepole pine, it does not appear to account for more than 25 percent of the cone-bearing trees in the stand.

It was noted that all tree species present produced cones during the last general cone crop in 1974.

Wildlife

Game

Both white tail (Odocoileus virginianus) and mule deer (Odocoileus hemionus) appear to be lightly using the upper slopes of the stand as evidenced by the pellet groups observed, tracks around the seep, light browsing on the shrubs and by visual sightings.

Elk (Cervus canadensis nelsoni) have not been observed in the stand but, periodically, individuals walk through the DF/Xete habitat type on the lower slope as indicated by tracks. Because very little browsing evidence has been found, it is felt that this is an infrequently used elk travel route.

Nongame

While no intensive surveys have been made to compile a complete list of all the mammals and birds inhabiting or traversing the site, the indicated presence of two is noted. Scattered eighteen-year-old girdling by porcupine (Erethizon dorsatum) in ponderosa pine has caused some damage with regard

to tree form, although little loss of merchantable fiber is expected. Also, pocket gophers (Thomomys talpoides) appear to be active in the DF/Feid habitat type.

Insects and Diseases

Western spruce budworm (Choristoneura occidentalis) has been infrequently active in the Twin Creeks drainages. Although the year of first infestation is not documented, the insects were active in the mid-1960's. A spray project in these drainages using Mexacarbate was undertaken in 1968 by the U.S. Forest Service (Johnson and Denton, 1975).

Douglas-fir tussock moth (Orgyia pseudotsugata), while never specifically reported in the West Twin Creeks drainage, was present in several locations in Western Montana during the period 1970-75. There is scattered incidence of defoliation that occurred about three years ago in some of the 30-40-year-old Douglas-fir in the stand. Three to six feet of the tops were completely killed. Falling some of these trees gave no clue as to what insect has caused the defoliation. It appears that the attack was short lived. No Douglas-fir shorter than fifteen feet exhibited any sign of defoliation. The form of the upper crown in some of the 30-40-year-old Douglas-fir had a distinctive "fiddle shape", indicating branch mortality in the past which suggests previous defoliation caused by an unknown agent.

No recent bark beetle activity has been observed in the stand. Mountain pine beetles (Dendroctonus ponderosae) are active on lodgepole pine in the upper Gold Creek drainage (6 miles northeast) and on ponderosa pine near the Lubrecht Experimental Forest (8 miles east).

Additionally, ponderosa pine were killed in 1974 between Marshall and Johnson Creeks (6 miles west) (USDA, 1975).

Western pine-shoot borer (Eucosina sonomana), while not present in this stand, has been identified in ponderosa pine plantations as close as 6 miles.

Although dwarf mistletoes do occur on both lodgepole pine (Arceuthobium americanum) and western larch (Arceuthobium laricis) in the Blackfoot River drainage, it has not been observed in this particular stand.

Recreation

Except for an occasional big game hunter using the road that forms the lower boundary of the stand, no recreational use is made of the lower portion of this drainage. At one time, there was a proposal to construct a ski facility on Sheep Mountain.

Snowmobiling is a winter sport use of the Wisherd Ridge area two and one-half miles west of this stand, but these portions of Sections 33 and 34 are not visible from either the access road to the Ridge or the Ridge itself.

II. HISTORY

This area was first mapped and cruised for the Big Blackfoot Milling Company in 1902 by a man named Fox. The merchantable volume was estimated at 4,970 board feet per acre.

A logging camp was established in 1919 on West Twin Creeks one-half mile upstream from the stand. This is also, coincidentally, the lowest point of a wildfire that burned about 200 acres south of West Twin Creeks (Section 33, T14N, R17W) during 1919.

The area of the present stand was logged using horses in 1921. Any tree that would make a mine stull was harvested. The areas east and west of this present stand were essentially clearcut. These stands are still drastically understocked.

III. MANAGEMENT OBJECTIVES AND CONSTRAINTS

Objectives

As a tax-paying private enterprise, with a large investment in land and timber, Champion Timberlands must harvest timber and at the same time keep the lands fully productive. The objective for the Company timberlands in Montana is to maintain a continuous log supply to the mills at Bonner without unnecessary environmental degradation.

Cuttings will be regenerated as promptly as possible in order to maintain and increase the productive capacity of the property. Water courses will be protected from increased sediment loads and from channel relocation caused by excessive skidding across the streams. The protection and improvement of wildlife habitat will be taken into consideration during the preparation and implementation of harvesting plans.

More specifically for the West Twin Creeks stand, Champion's "Silvicultural Practices" report (1974) identifies the DF/Xete and DF/Caru habitat types as "Intensive Culture Areas" where we will manage for a maximum return on our investment, while the other portions of the stand are classified as "Special Impact Areas" because of their desirability as a wildlife winter range.

Constraints

1. We must operate within all applicable Federal and State laws

as they pertain to hazard reduction, streambed protection, and maintenance of water quality.

2. The minimum merchantable tree is one having a 16-foot log to a 6-inch top diameter, inside bark.
3. We must remove at least 1,000 board feet per acre, in trees 12 inches d.b.h. and larger, at any commercial entry.
4. Our silvicultural policy does not allow for clearcuts, seed tree cuts, or artificial seeding on this soil series.
5. Our silvicultural policy only allows for individual tree selection or salvage harvesting on the DF/Agsp habitat type.
6. The stand is located in an area managed through a cooperative agreement with the University of Montana which directs the University to manage the resource "in order to provide practical training for its students, and to enable its faculty and students to develop new tools and techniques for forest resource management."

IV. ALTERNATIVES

Do nothing to the stand until it reaches 60 years of age and then harvest the merchantable volume using a single-step shelterwood system. (Alt. A)

This alternative treats the total area as a single unit. While the objective of producing logs for the mill would be met, we would be doing nothing to enhance the productivity of the site. The major concern is with the DF/Agsp habitat type. In this area we would be neglecting the value of the wildlife winter range. Additionally, we would be violating constraint number 5.

It is projected that few stems per acre would be left on the DF/Agsp area while the other timbered habitat types would have approximately 380 stems per acre remaining following harvest of the overwood.

At first thought, the lack of financial investment may be assumed to result in a greater return at the time of harvest, but the recurring costs of land ownership (fire protection, taxes, administration) result in a net present worth of only \$13.71 per acre.

This alternative would have undesirable genetic impacts and would also create regeneration problems in the DF/Agsp area because of environmental stress due to solar exposure.

The single entry into the stand should result in little logging damage to the residual stand as well as causing slight soil compaction.

Of the three proposed alternatives, this one would have the greatest visual impact, especially on the upper slopes where most of the timber would be removed.

Only salvage mortality on the
DF/Agsp habitat type and
convert the other timbered
habitat types to an uneven-aged
stand using a 40-year
regulation period. (Alt. B)

Figure 4 on page 11 shows the proposed stocking levels by diameter class of the fully regulated stand.

By treating the DF/Agsp area separately, the management objectives and constraints are satisfied. Maintaining high stocking levels in the smaller diameter classes allows a hedge on potential mortality, but the trade-off is a reduced financial return compared to Alternative C (present net worth = \$34.38 per acre).

There is no provision for any special treatment of the seep and DF/Feid areas. While this will probably not result in a negative impact on water quality and wildlife, it does not enhance the present condition of these resources.

An entry into the stand every 20 years will give a tree two more opportunities to be damaged through harvesting activities than would occur in Alternative A.

Repeated use of the same skid trails may cause increased soil compaction over Alternative A, but should not be severe because of the great abundance of coarse fragments and low proportion of clay in the soil profile (USDA, 1972).

The genetic diversity of this stand should be increased by not creating a dysgenic bottleneck through the removal of all of the merchantable trees, although maintaining a larger number of stems per acre encourages inbreeding (Smith, 1962).

This management regime should result in a low, negative visual impact because a continuous tree canopy is maintained.

Define three management units
with intensive, uneven-aged
culture in the DF/Caru and
DF/Xete habitat types, salvage
only of merchantable fiber from
the DF/Agsp habitat type,
and no mechanical disturbance or
timber harvest in the seep
and DF/Feid areas. (Alt. C)

Figure 4. shows the proposed stocking levels by diameter class which are different from those in alternative B. It does not, though, have as large an allowance for mortality in the nonmerchantable diameter classes, yet does allow for the mean annual mortality experienced on this soil type (Hite, 1974).

This alternative satisfies all management objectives and constraints and strives to fully protect the soil and water resources while improving the potential for wildlife use. It also has the potential for the greatest financial return (present net worth = \$38.47 per acre).

Twenty-year entries into the stand should result in the same potential residual tree damage and soil compaction as briefly described in Alternative B.

28 | 27

33 | 34

T14N, R17W



- Unit 1 - 
- Unit 2 - 
- Unit 3 - 

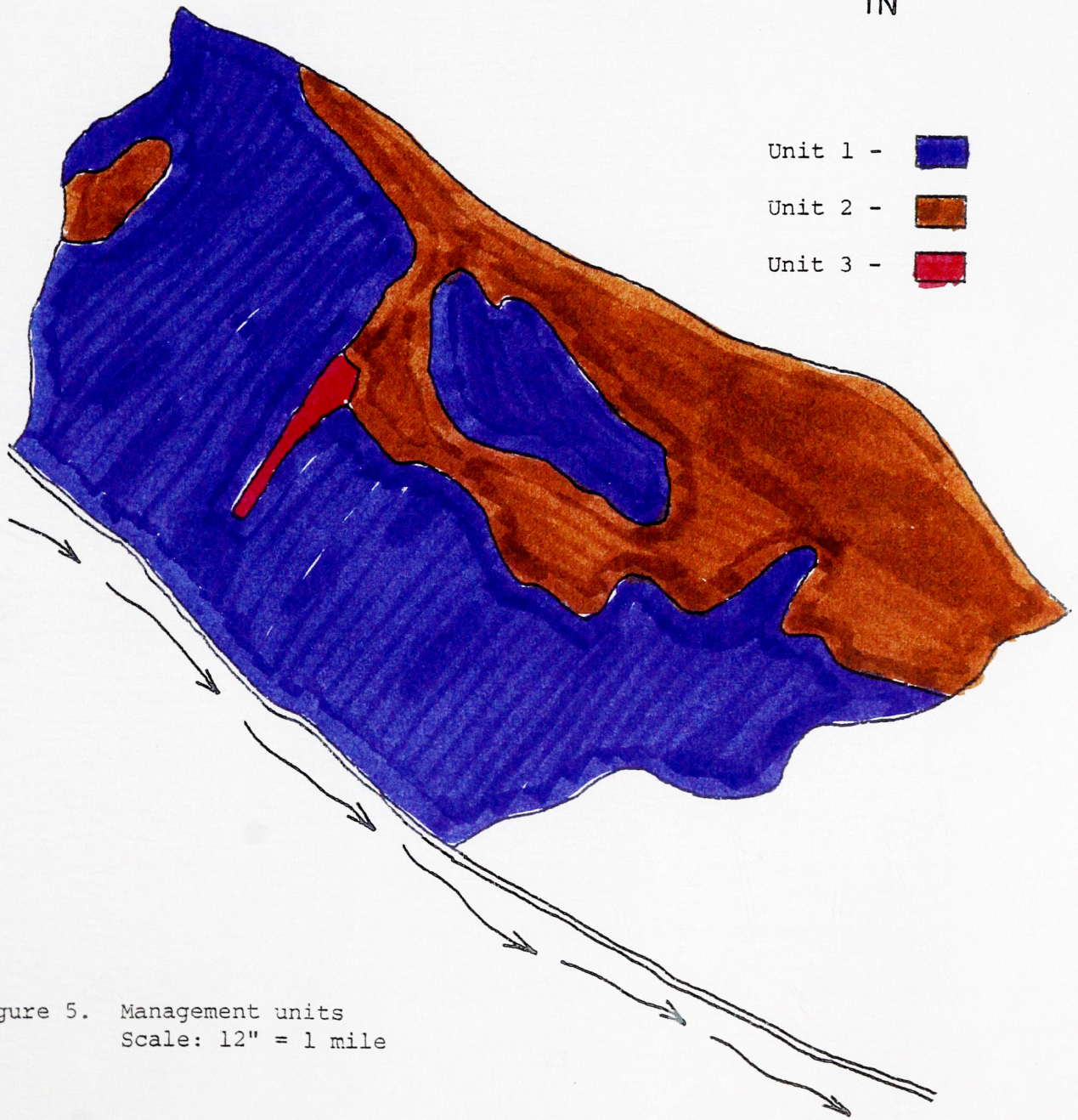


Figure 5. Management units
Scale: 12" = 1 mile

The genetic and visual considerations will also be similar to Alternative B.

This alternative is optimum and greater discussion of resource impacts will be made in the following section.

V. PRESCRIPTION

This stand will be managed as three distinct units (Figure 5.):

Unit 1 - Composed of the DF/Caru and DF/Xete habitat types, this unit will be most intensively managed using a forty-year regulation period to accomplish conversion to a modified, balanced, uneven-aged stand that will be subsequently entered at ten-year intervals. Area: 46.9 acres.

Unit 2 - This area includes the DF/Agsp habitat type and the associated NF/Agsp union where only salvage of dead merchantable wood fiber will occur. Area: 26.2 acres.

Unit 3 - The wet seep and DF/Feid habitat type comprise this unit where no timber harvesting or mechanical disturbance will occur. Area: 0.6 acres.

Treatment of Unit 1

Based upon permanent inventory plots and the Corporate prognosis model that predicts whole stand development over time (Hite, 1974), the optimum stocking level on this soil series to maintain a .2 inch annual diameter growth rate is eighty square feet of basal area. It is desirable to have this stocking concentrated in merchantable fiber while allowing adequate nonmerchantable stems for ingrowth. A diminution quotient of 1.4 for stems eight inches and greater and "normal" mortality estimates for diameters less than eight inches

produces a stand structure that maximizes board foot volume yield while maintaining eighty square feet of basal area per acre.

All harvesting will be by crawler tractors without blades in order to minimize damage to the residual stand and disturbance to the grass, forb and shrub vegetation.

Where it is necessary to skid logs across Unit 2 (middle of the stand), only one trail will be used with erosion barriers constructed by hand after completion of skidding. The trail will be seeded with native grasses the following spring.

Within Unit 1, skid trails will be marked prior to harvest and all logs will be winched to these trails. Each trail will have water bars hand constructed upon completion of its use. Seeding with native grasses and shrubs will occur the following spring. These trails should not be reused in subsequent harvesting operations.

Logs may be decked on the lower side of the road, but all debris must be hand piled after the logs are loaded. This residue will be burned during the fall of 1976. Native grasses and shrubs will be seeded on the disturbed fill slope during the spring of 1977.

Harvesting, cleaning and slash piling will occur between July 1, 1976 and September 1, 1976 to minimize big game disturbance. The cleaning of excess nonmerchantable stems (Table 3) will be made concurrent to the harvest. All slash should be hand piled away from live residuals and burned the fall of 1976.

An inventory of stems per acre by diameter class should be made the summer of 1977 to determine if the cultural activities of 1976

left the desired stocking. Another inventory should be made in 1986, just prior to the next regeneration period to again assess the stocking distribution.

If there are not sixty-eight seedlings per acre, enough containerized ponderosa pine and Douglas-fir should be planted in thirty-six-inch circular, hand scarified sites so that as near a 50:50 species balance at the desired stocking level is achieved.

Treatment of Unit 2

Any dead merchantable trees will be harvested concurrent to the harvest in Unit 1. Crawler tractors without blades will be used. A skid trail may be used for only one drag of logs.

All slash will be lopped and scattered at the time the tree is felled. This residue will not be burned.

Treatment of Unit 3

No skidding activity will occur in or through this unit. A small basin, about three-foot square, will be hand shoveled where the water surfaces. This will create a small catchment to provide water for big game. This work should be done at the time Unit 1 is marked for cut and should be re-examined during harvest of Unit 1 to assess its permancency.

VI. IMPACT ASSESSMENT

Economics

This project is estimated to have a total present net worth of \$2,835.90 and a benefit/cost ratio of 1.87:1 for the forty-year regulation period. The analysis evaluates benefits from harvesting in 1976, 1996 and 2016. The cost of cleaning is calculated in 1976. Planting costs are evaluated at ten-year intervals from 1986 to 2016. A one-time opportunity cost is assessed against the timber in the areas being managed primarily for big game. Recurring costs of taxes, fire protection and administration are assessed on an annual basis.

After 2016, the fully-regulated stand is economically evaluated every ten years. For each period, the total present net worth is \$382.48 and the benefit/cost ratio equals 1.44:1, assuming an interest rate of eight percent.

Soils and Erosion

Because the soil on this site is quite shallow and the slopes are steep, the potential for a negative impact is great unless care is used to assure minimum soil movement (USDA, 1972). It may be most desirable to use a helicopter, balloon or cable harvesting system on this site to reduce the disturbance from skidding (Binkley 1969, McIntosh and Wright 1970), but this is economically unfeasible, because of the low volume per acre removals. Additionally, the skyline system would

require a road and landings near the ridge top in Unit 2 which would be undesirable from a soils, wildlife and visual standpoint.

Keeping the blades off the crawler tractors will remove the temptation for the operators to be aspiring road builders.

Marking the skid trails and requiring winching will reduce unnecessary disturbance that is normally associated with "cruising around looking for logs". This will also reduce the linear footage of trails that will be water barred and seeded.

A three-year-old example of these requirements on similar aspects, slopes and soils is found within one-quarter mile of this stand. It is a success.

The water barring will reduce the velocity of any rain wash and snow melt water on the disturbed surface and will reduce soil movement. It will also move this water into adjacent undisturbed vegetation where infiltration rather than overland flow may occur.

The seeding and subsequent growth will reduce the impact of the raindrops through interception by the vegetative cover. This cover will also allow more infiltration and less overland flow of water (Leaf, 1975).

An increase in soil bulk density will likely occur, although the lack of fine particles in this soil and the prompt revegetation of the disturbed areas should minimize the increase (Steinbrenner and Gessel, 1955). No estimates of magnitudes are available (USDA, 1972, Rice et al., 1972).

Keeping machinery out of Unit 3 will prevent displacement or

compaction of the wet soil (Steinbrenner, 1955). This will also allow the present surface and subsurface water flow patterns immediately below the seep to remain intact.

The allowance of only one trip per skid trail in the salvage of wood fiber in Unit 2, should minimize vegetative disturbance and soil compaction (Foil, 1965). If any mineral soil is exposed during the skidding, it will probably be intermittent and should not result in high velocity overland water flows.

In moving the logs from the isolated segment of Unit 1, a single crossing of Unit 2, over which all of the logs will move, will concentrate the rehabilitation effort in one location. The water barring and prompt revegetation will reduce the erosion potential. More soil compaction will likely occur here than on any other skid trail in the stand (Foil, 1965). The seeded grasses will begin to reduce the soil bulk density through the actions of the roots, but a total response is not likely prior to re-entry of the stand. Thus, productivity in this narrow corridor will be sacrificed rather than risking possible degradation of many less-used crossings.

Piling the residue on the road toe slope after hauling the decked logs may create more soil movement than would occur if the material were left in place to impede water flow. The piling is intended to reduce the negative visual impact. Prompt revegetation the spring after use should reduce the duration of the potential hazard. Because a 150-foot vegetated strip lies between the road and West Twin Creeks, the hazard is not that soil will move into the stream (Haupt and Kidd,

1956), rather it is that the road fill may slightly erode, narrowing the road and thus creating a need for reconstruction at the next entry into the stand.

Hydrology

This harvest system is expected to increase the amount of snow accumulation over the uncut stand very little. Because there will be some holes created in the present crown canopy in Unit 1, the rate of snowmelt in the spring will be slightly increased (Berndt, 1961), although water yield from the stand is not expected to increase appreciably compared to the present (USDA 1964, Reinhart et al., 1963).

Climatology

There will be an increase in both soil and surface air temperature where trees are removed. Additionally, reflectivity of solar radiation will increase from these openings (Brown, 1972).

Regeneration and Genetics

These two topics are inter-related in this stand and will be discussed as such. Because of: (1) the potential for dysgenic selection by harvesting the largest trees (Smith, 1962), (2) the potential genetic inferiority of the present stand because of past harvesting practices, and (3) the expense of repeated stand cleanings, every attempt will be made to discourage any further natural regeneration in preference to the possibility of using planting stock grown from tested, improved seed trees.

Discouragement of natural regeneration is being promoted by retaining as solid a cover of competing vegetation as possible through

minimizing vegetative disturbance and prompt revegetation of areas that are denuded (Larson and Schubert, 1969). The only exception is the removal of a thirty-six-inch circle of competing vegetation at each planting site (Loewenstein et al., 1968). Douglas-fir is not influenced by competing vegetation as greatly as is ponderosa pine (Roeser, 1924), thus we expect some natural regeneration of this species.

Very little has been mentioned to this point about the pocket gophers in Unit 3. That is, because we know very little about the pocket gophers in Unit 3! They seem to be nowhere else in this stand, possibly due to moisture limitations. Until they become active in the intensively cultured area (Unit 1), we will be satisfied with coexistence.

Tree Growth

It can be expected that some release will occur when the stand is harvested and cleaned. In light partial cutting, the greatest growth response will most likely be in pole and small sawtimber sized trees (Smith, 1962, Pearson, 1940, Boe and Tackle, 1956). Severe bole or crown damage through harvesting activities will reduce subsequent growth on the affected trees.

Insects and Diseases

Little increase in the destructive activity of heterotrophs is expected because most injurious species do not attack all age classes of a given tree species (Smith, 1962). Additionally, while insect numbers may increase, the numbers of insect predators is also expected

to increase following selection cutting (Reid, 1957).

In ponderosa pine, reduced insect infestation and loss has been reported after selection logging of high risk trees (Salman and Bongberg, 1942) or sanitation-salvage cutting (Sowder, 1951, Wickman and Eaton, 1962). Summer harvesting in ponderosa pine has the potential for increasing the incidence of Ips sp. beetle attack. This risk is a trade-off for wildlife benefits, which are anticipated to result from altering the harvesting period.

Dwarf mistletoe will infect any size class, age class or crown position tree of a given species. Frequent observations should be made to determine if it becomes established in the stand.

Increasing residual tree exposure to fungal diseases through logging scars or stumps may result in the introduction of root and heart rots into the stand. It is felt that decay associated with scars will be minimal (Craig, 1970). Retaining a mixed stand of Douglas-fir and ponderosa pine should reduce the incidence of root grafts and thus minimize the occurrence of root rot damage. The best preventative measures appear to be prompt disposal of harvesting slash and reduction of physiological stress in the residual stand (McGregor and Shipe, 1975, Clark, 1953). Both of these actions will occur in this stand.

Slash

Hand piling and prompt burning should reduce the fire hazard in Unit 1.

The salvage of mortality along with the lopping and scattering

of all residue in Unit 2, should keep the fire hazard low in this area.

Because a step-like arrangement of crowns occurs in an uneven-aged stand, if a fire should start, the potential for crowning out is greater than in a single-storied stand (Smith, 1962).

Wildlife

Summer harvesting will minimize the big game disturbance by operating when the animals are not on the site.

Selection harvesting in Unit 1, will allow maintenance of protective screening from the road (Lyon, 1975). Prompt slash disposal will keep impediment to travel at a minimum.

Minimizing timber removal in Unit 2, will maintain the grazing potential on the preferred upper slopes which receive high intensity solar radiation.

Maintaining an uncut stand in Unit 3, will offer a "safe" area near the water source.

Visual

The minimal disturbance prescribed for the stand can be classified as retention of the present visual resource (USDA, 1974). Cleaning up the logging residue left below the road will give a psychological feeling of completion rather than the idea that the logger got tired of the area and just left.

Table 3.--A time table for stand treatments.

DATE	DIAMETER RANGE	PRESENT STEMS/AC.	DESIRED STEMS/AC.	EXPECTED MORTALITY	REMOVE STEMS/AC.	HARVEST BOARD FOOT VOL./AC. (6" TOP)
1976	12"+	11	0	0	11	1132
	10"--12"	18	28	1	0	
	8"--10"	4	39	0	0	
	6"--8"	11	55	0	0	
	4"--6"	25	57	1	0	
	2"--4"	72	60	3	9	
	0"--2"	293	62	11	220	
	<u>Regen.</u>	<u>86</u>	<u>65</u>	<u>3</u>	<u>18</u>	
	<u>Totals</u>	<u>520</u>	<u>366</u>	<u>19</u>	<u>258</u>	<u>1132</u>
1986	12"+	17	0	0	0	0
	10"--12"	4	28	0	0	
	8"--10"	11	39	0	0	
	6"--8"	24	55	1	0	
	4"--6"	60	57	3	0	
	2"--4"	62	60	2	0	
	0"--2"	65	62	3	0	
	<u>Regen.</u>	<u>68</u>	<u>65</u>	<u>3</u>	<u>0</u>	
	<u>Totals</u>	<u>311</u>	<u>366</u>	<u>12</u>	<u>0</u>	<u>0</u>
1996	12"+	21	0	0	21	1008
	10"--12"	11	28	0	0	
	8"--10"	23	39	1	0	
	6"--8"	57	55	2	0	
	4"--6"	60	57	3	0	
	2"--4"	62	60	2	0	
	0"--2"	65	62	3	0	
	<u>Regen.</u>	<u>68</u>	<u>65</u>	<u>3</u>	<u>0</u>	
	<u>Totals</u>	<u>367</u>	<u>366</u>	<u>14</u>	<u>21</u>	<u>1008</u>
2006	12"+	11	0	0	0	0
	10"--12"	22	28	1	0	
	8"--10"	55	39	2	0	
	6"--8"	57	55	2	0	
	4"--6"	60	57	3	0	
	2"--4"	62	60	2	0	
	0"--2"	65	62	3	0	
	<u>Regen.</u>	<u>68</u>	<u>65</u>	<u>3</u>	<u>0</u>	
	<u>Totals</u>	<u>400</u>	<u>366</u>	<u>16</u>	<u>0</u>	<u>0</u>
2016	12"+	32	0	0	32	1350
	10"--12"	52	28	2	22	462
	8"--10"	55	39	2	14	112
	6"--8"	57	55	2	0	
	4"--6"	60	57	3	0	
	2"--4"	62	60	2	0	
	0"--2"	65	62	3	0	
	<u>Regen.</u>	<u>68</u>	<u>65</u>	<u>3</u>	<u>0</u>	
	<u>Total</u>	<u>451</u>	<u>366</u>	<u>17</u>	<u>68</u>	<u>1924</u>
2026	FULLY REGULATED UNEVEN-AGED STAND					
	12"+	28	0	0	28	1008
	10"--12"	39	28	2	9	189
	8"--10"	55	39	2	14	112
	6"--8"	57	55	2	0	
	4"--6"	60	57	3	0	
	2"--4"	62	60	2	0	
	0"--2"	65	62	3	0	
	<u>Regen.</u>	<u>68</u>	<u>65</u>	<u>3</u>	<u>0</u>	
	<u>Totals</u>	<u>434</u>	<u>366</u>	<u>17</u>	<u>51</u>	<u>1309</u>

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